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ABSTRACT

A study was conducted to determine if there were significant differences in vision between beginning readers who learn to read easily and those who learn with difficulty (dyslexics). In addition, the study examined the mean of the high achievers (rather than expert opinion) to discover the degree to which visual efficiency was normally needed for successful reading acquisition. Subjects were 144 students in the first and second grade classes in a Texas public school. Each child was individually tested at the end of the school year on 25 visual factors by an examiner who did not know the child's reading group placement. Results revealed significant differences in visual function between high and low reading achievers across grade, sex, age, and teacher effects. The mean scores of the high achievers were higher than those of the poor achievers on almost all measures, including binocular function (far-point vertical alignment, stereopsis, and fusion) and near-point visual acuity. Among the 19 first grade nonreaders, there were 18 cases of binocular problems and 17 cases of inadequate visual acuity--six times the number of visual problems found among the high achievers. The findings indicate that up to 95% of the reading disabled may be mislabeled, and that most of their difficulties could be prevented by a rigorous kindergarten or preschool visual screening and follow-up program. (FL)

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ED268498

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A Study of Visual Efficiency Necessary For Beginning Reading

Purpose.

The purpose of this study was to determine whether there was a significant difference in visual function between: a) primary children whom the teachers perceive as learning to read easily and those whom teachers perceive as learning to read with more difficulty, defined as the three reading groups, group A, high, group B, average, and group C, low; b) whether there was a significant difference in visual function between the mean of non-readers and the mean of their grade; c) between the mean of non-readers and the mean of group A; d) between first and second grade; e) between primary boys and primary girls; f) between six, seven, and eight year olds; and g) to establish a norm or baseline of visual proficiency needed in first and second grades for successful academic achievement, as measured by the Keystone Visual Survey.

Subjects.

This study was conducted in a public elementary school in an East Texas town of approximately 30,000. The entire population of one hundred forty-four, 67 first and 77 second graders, of one attendance center was utilized. There were eight self-contained classrooms with each divided into three reading groups, high, A, average, B, and low, C, achievers. The children ranged in age from six to nine years, with a mean of seven years and three months. Socio-economic levels ranged from low to upper middle class. Approximately sixty percent of the children studied were Caucasian, thirty percent Negro, five percent Mexican, and five percent Oriental. Fifty-five percent were boys while 45 percent were girls. Fifty-two percent of the First grade and fifty-seven percent of the Second grade, respectively, were male.

Procedure.

The Psychologist-Director of the University Learning Center administered the test battery to all children individually in a private conference room at their attendance center. At the time of testing the examiner had no knowledge of any child's reading placement. Testing extended from 8:30 a.m. to 3:30 p.m. during a two week period. Testing required about 20 minutes per subject. No child was omitted. If absent, a child was tested at a later date within the two week period. Each child was given the fourteen subtests from the Keystone Visual Survey and his/her visual proficiency was further evaluated using the Moving-Eye Camera (Eye-Trac Model 106 by G-W applied Science Laboratories). The paragraph used with the moving-eye camera was level one. If there was a question concerning a child's ability to read, she/he was asked to read orally from the card before his/her eyes were tested. Comprehension above 60 percent was required for the test to be valid. Among the poor readers, there were 21 who could not read well enough to meet this standard and, therefore, only the Keystone Visual Survey was administered to those subjects.

Although all mainstreamed children were included, no child whose total instruction was under special education was involved, since they were at another attendance center.

If a child wore glasses, she/he was tested both with and without his/her prescription. The data while wearing the prescription was entered into the tables.

The tape from the Moving Eye Camera was tabulated by three different evaluators. If the tape scoring differed in any way, the three evaluators conferred and recounted the tape.

The results from the Keystone Visual Survey and the Moving Eye Camera were subjected to two ANOVAs to determine significant differences in visual function. There was one three-way ANOVA which used reading group, sex, and grade. The reading groups were composed of the high group. A, (the highest achieving reading group from each of 8 self-contained classrooms, four 1st grade rooms and four 2nd grade rooms), the average reading group, B, (the composite of the 8 average groups from the first and second grades), and the low reading group, C, (the composite of the 8 groups of slower readers in each of the 8 self-contained classrooms, including both first and second grades).

The second ANOVA used reading group and chronological age. The means of two subgroups, the non-readers and the children wearing prescriptive lens, were then compared with grade level mean and Group A mean in each of the factors one through fifteen.

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Factors one through fifteen were comprised of the 15 subtests of the Keystone Visual Survey (KVS). Factors 16 through 25 were measurements obtained from each subject's eye tapes.

Measurements Defined.

The term Binocular efficiency refers to Lateral and Vertical Posture, Fusion and Stereoposis as measured by the Keystone Visual Survey and Factors 16 through 25 taken from the Moving Eye Camera. None of the 144 subjects in this study had any phorias that were visable to the unaided eye.

Factor 1, Simultaneous vision determined whether a subject used both eyes for sight.

Factor 2, Vertical Posture measured whether one eye sighted higher than the other at far point, chalkboard distance, 20 ft. In a severe case, one eye could focus on one line while the other focused on a line of print above or below during reading from a chart or chalkboard.

Factor 3, Lateral Posture measured the degree to which both eyes focused at a single point on a horizontal axis at far point. In a severe case, each eye might focus straight ahead inward or outward, causing the subject to be viewing two different positions or words on a line simultaneously.

Factor 4, Fusion measured the synchronization of both Factors 2 and 3 at far point.

Factors 5, 6, and 7, measured visual acuity, sharpness of image, at far point for both eyes, right eye only, and left eye only, respectively.

Factor 8, Stereopsis indicated whether the eyes coordinated well enough at far point to form the difference in angle of vision required for depth perception.

Factors 9 and 10, dealt with color perception, green, yellow, blue, and red. These would have a little application in reading black print from a white page or white chalk from a black board, but in the case of a green chalk board and yellow chalk, or purple ink, as in dittos, or colored paper in text books, this problem could cause the colored print to entirely disappear if the deficiency were severe. It also has major applications in daily living, for example, stop signs while driving.

Factor 11 measured lateral posture (see #3) at near point (book distance).

Factor 12 measured fusion (see #4) at near point.

Factor 13, 14, 15 measured visual acuity (sharpness of image) at near point.

The next 10 factors, 16 through 25, were measures taken by use of the Moving Eye Camera. The specific measurements were ones which have had very little attention or collection to date. Most studies of eye movement have concentrated on fixations and regressions or length of fixations while reading. Those movements, while not usually under conscious control are done in response or in accord with purposeful activity in the mind of the subject. The movements measured by this study are the ones which appear to be uncontrolled or uncontrollable and/or in direct conflict with the purpose of the subject. For example:

Factors 16 and 17 measured the periods of time when either the right or left eye, respectively, become rigidly fixed on a point, while the opposite eye continued reading in a normal fashion.

Factors 18 and 19 measured the time elapsed when either the right or left eey, respectively, exhibited gross tremors while the opposite eye exhibited either normal or different movement.

It was assumed that the reader intended to move from the end of one line of print to the beginning of the next, either of the same line or the following line in Factors 20 through 23..

Factors 20 and 21 measured the number of fixations made by the right or left eye, respectively, during its return sweep to the left side of the page.

Factors 22 and 23 measured the number of times that either the right or left eye, respectively missed the first word or letter of the following line and have to relocate before beginning to read.

Factors 24 and 25 measured the time elapsed when right or left eye, moved in a clearly divergent direction to the opposite eye with no apparent fixations, appearing to drift out of control and without regard to the line of print.

All of these factors measured by the eye-tapes were movements which appeared to be random and unrelated in any way to the subjects intent. Movements in which the brain did not control or had lost control of purposeful or coordinated movement. In earlier research, the authors had observed an increase in this type of eye movement among subjects with reading problems who had had a history of severe illness or accidents, suggesting momentary lapses of control.

TABLE I

Percentage of Students Showing Visual Deficiencies
In Each of the Subtests From Keystone
Visual Survey and Moving-Eye Camera

Subtest N	Percentage
Far Point Vision	
Simultaneous Vision (N, 144)	0
Vertical Posture (N, 144)	5
Lateral Posture (N, 144)	11
Fusion (N, 143)	10
Useable Vision (both eyes) (N, 144)	9
Useable Vision (right eye) (N, 144)	15
Useable Vision (left eye) (N, 144)	15
Stereopsis (N, 143)	16
Color Perception (N, 144)	7
Color Perception (N, 144)	6
Near Point Vision	
Lateral Posture (N, 144)	14
Fusion (N, 143)	20
Useable Vision (both eyes) (N, 144)	40
Useable Vision (right eye) (N, 144)	38
Useable Vision (left eye) (N, 144)	43
Rigid Right (N, 123)	8
Rigid Left (N, 123)	7
Tremor Right (N, 123)	9
Tremor Left (N, 123)	7
Fixation on Return Sweep (R) (N, 123)	8
Fixation on Return Sweep (L) (N, 123)	9
Refixation on Return Sweep (N, 123)	8
Refixation on Return Sweep (N, 123)	7
Divergent Right (N, 123)	25
Divergent Left (N, 123)	34

Results.

Statisticly significant differences in visual function were found: a) between reading groups, b) between ages, c) between grades, and d) between sex, together with some interesting and significant interactions.

In Table I, the relative frequency of the various deficiencies in the total group are depicted. Both binocular problems and visual acuity problems seem to occur with about equal regularity. Problems with Near Point Visual Acuity were the most common followed by Divergent movements with either the Left or Right Eyes, Near Point Fusion, Stereopsis, Far Point Visual Acuity in either eye, Near Point Lateral Posture, Far Point Lateral Posture and Fusion in that order. Other problems, though comprising less than 10% of the cases, were extremely handicapping in individual cases.

In the three-way ANOVA, (see Table II), there was a statistically significant (.05) difference between reading groups in: 1) Vertical Posture, 2) Stereopsis, 3) Near Point Visual Acuity, right eye, and 4) Number of Fixations on the return sweep, left eye. The mean of the high reading group, Group A, was the best in each case. For example, on the Keystone VS test item, Near Point Vision, right eye, Group A's mean was 97.8% compared with 90% for Group C, a difference of 7.8% in favor of Group A. Similar findings were illustrated by Stereopsis. Group A obtained a mean of 1.14 compared to 1.70 for Group C, a difference of .56 or 28% in favor of the better readers.

Visual Posture at Far Point and Number of Fixations on Return Sweep, left eye, also showed significant difference between reading groups in favor of the high achievers. (See Table II).

Since the reading groups included 24 subgroups which crossed grade level and included eight different teacher's classrooms, these findings should be most devoid of any bias caused by teacher effect, reading practice, and maturity or chronological age.

Between first and second grades, statistically significant differences were found between 1) Far Point Useable Vision, (acuity), Left Eye, 2) Stereopsis, 3) Near Point Useable Vision (acuity), Right Eye, 4) Near Point Useable Vision, (acuity), Left Eye, 5) Number of Fixation on Return Sweep, Left Eye. In addition Far Point Useable Vision, Right Eye lacked only .001 of showing Significance at .05. In each case, the second grade mean was superior (See Table II). However, an unknown amount of this improvement was due to eleven second graders wearing prescriptions while only 3 first graders had been so fitted. Among the second graders wearing glasses, 4 were functioning within the A Group, 5 within the B Group and 2 within the C Group, which approached a normal distribution. The three wearing glasses in the first grade were all within Group B.

The question arose as to what the results would have shown had the data been recorded without prescription. The answer was that almost no data could have been recorded for those children, because without prescriptions their vision was so impaired that they could read almost nothing so that no Eye-Tape could have been made. Without glasses they all scored below 80% (usually between 60-80) at Far Point Acuity on the Keystone VS, and much less or nothing at all on any of it's subsequent measures.

There was a significant difference between sex in Color Perception (blue-red, only) and in Useable Vision, Near Point, Both Eyes, both favoring the girls (See Table II). Since Color Perception has been long known to be a sex-linked characteristic, this difference was not unexpected. Possibly girls earlier maturity rate caused the shift from far-sightedness to occur earlier and be more complete in primary girls than for the boys, therefore, the more efficient Near Point Vision.

An interesting and totally unexpected phenomenon appeared when the second grade has a significantly greater number of Fixations on Return Sweep than did the First Grade while reading the same Level One paragraph. The reading groups, high, average and low had performed exactly as had been predicted across grade levels, with none of the high groups in either grade exhibiting a single instance of Fixation On Return Sweep. The low group, Group C, had the highest mean (both right and left eye), the average group, Group B, placed between Groups A and C.

The boys had significantly fewer Fixations On Return Sweep than the girls which suggested that there were real, but as yet unknown factor or factors involved in the development of the smooth return sweep when reading. Of course, these findings being in both grade and sex, caused significant interaction between grade and reading group. An explanation for this phenomenon must be left for further research. However, the fact that it occurred twice in both right and left eyes gives the findings more credence.

TABLE II

Three Way Analysis of Varience Showing Grade, Sex, and Reading Groups

Test Item (Far Point)	Range Of Perfect Score (Low to High)	Grade Mean		Sex Mean		Reading Group Mean			Main Effect			Interactions			
		1st	2nd	Boy	Girl	High	Ave	Low	Grade (F1,144)	Sex (F1,144)	Rd. Group F(2,144)	Grade & Sex F(1,144)	Grade & Rd. Group F(2x144)	Sex x Rd. Group F(2x144)	Gx Sx Rd. Group F(2x144)
Simultaneous Vision	3 - poor 1 - perfect	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.00	.00	.00	.00	.00	.00	.00
Vertical Posture	3-1	1.18	1.05	1.15	1.05	1.04	1.02	1.13	.32	.42	*4.58	.03	*3.08	1.26	.13
Lateral Posture	3-1	1.17	1.14	1.16	1.15	1.21	1.14	1.13	1.02	1.02	.47	.44	.31	.08	2.18
Fusion	3-1	1.15	1.22	1.17	1.22	1.12	1.34	.31	.31	.49	2.68	1.58	.09	.15	1.69
Useable Vision both Eyes	49-105	99.04	102.20	101.85	99.49	98.19	102.10	101.76	3.21	.38	1.33	.02	.12	.24	.22
Useable Vision Rt. Eye	49-105	97.77	101.22	100.37	98.69	98.10	101.80	98.11	*3.72	.31	1.30	.00	.21	.03	.67
Useable Vision Lt. Eye	49-105	96.22	100.96	99.51	97.86	97.32	101.42	96.42	4.51	.01	1.58	.86	1.33	1.16	.24
Stereopsis	3-1	1.42	1.16	1.16	1.31	1.15	1.17	1.63	*13.10	1.00	*7.65	*4.09	*3.85	.33	*3.87
Color Perception	3-1	1.16	1.05	1.16	1.03	1.06	1.12	1.13	3.46	3.32	.21	.63	.65	.22	.08
Color Perception	3-1	1.13	1.08	1.18	1.02	1.13	1.10	1.08	.62	*6.29	.63	1.17	.02	.25	.05

* Statistically significant

TABLE II

Three Way Analysis of Varience Showing Grade, Sex, and Reading Groups

Test Item (Near Point)	Range Of Perfect Score (Low to High)	Grade Mean 1st	Grade Mean 2nd	Sex Mean Boy	Sex Mean Girl	Reading Group Mean High	Reading Group Mean Ave	Reading Group Mean Low	Main Effect Grade (F1,144)	Main Effect Sex (F1,144)	Main Effect Rd. Group F(2,144)	Interactions Grade & Sex F(1,144)	Interactions Grade & Rd. Group F(2x144)	Interactions Sex x Rd. Group F(2x144)	Interactions Gx Sx Rd. Group F(2x144)
Lateral Posture	3-1	1.16	1.22	1.16	1.18	1.13	1.15	1.26	.30	.00	.88	2.00	2.76	*3.24	.31
Fusion	3-1	1.39	1.36	1.37	1.38	1.26	1.44	1.44	.08	.49	1.09	.13	.95	.28	.18
Useable Vision Both Eyes	10-105	92.26	94.53	90.92	95.71	96.03	92.74	87.71	1.98	*6.64	.81	.77	.16	2.32	.10
Useable Vision Rt. Eye	10-105	91.70	95.57	93.47	95.56	97.81	94.58	90.00	*8.80	.54	*4.43	.03	*3.98	.98	.26
Useable Vision Lt. Eye	10-105	88.38	95.15	91.70	92.35	93.91	91.74	90.05	*9.62	.31	.69	.00	*2.91	1.58	.52
Rigid R. Eye	∞ -0	.23	2.13	1.18	.86	.33	1.98	2.11	1.54	.03	.37	.00	.22	.09	.01
Rigid L. Eye	∞ -0	.23	4.24	2.00	2.05	.00	4.00	2.03	2.20	.06	1.94	.15	1.51	.35	.57
Right Tremors	∞ -0	1.56	1.38	2.10	.68	.00	2.13	1.81	.00	.25	2.12	.02	.50	.18	.12
Left Tremors	∞ -0	2.85	1.39	2.41	1.52	1.43	2.62	1.84	.14	.07	.34	.32	.36	.82	.12

* Statistically significant

TABLE II

Three Way Analysis of Varience Showing Grade, Sex, and Reading Groups

Test Item (Near Point)	Range Of Perfect Score (Low to High)	Grade Mean		Sex Mean		Reading Group Mean			Main Effect			Interactions			
		1st	2nd	Boy	Girl	High	Ave	Low	Grade (F1,144)	Sex (F1,144)	Rd. Group F(2,144)	Grade & Sex F(1,144)	Grade & Rd. Group F(2x144)	Sex x Rd. Group F(2x144)	Gx Sx Rd. Group F(2x144)
Fix On Rt. Sweep Rt.	∞ -0	.02	.53	.02	.57	.00	.39	.79	*6.23	3.23	2.13	2.67	1.97	.96	.80
Fix On Rt. Sweep Lt.	∞ -0	.02	.51	.21	.45	.00	.33	.82	*9.04	*4.49	*3.51	*3.71	*3.47	1.85	1.94
Fix On Rt.	∞ -0	.23	.19	.19	.21	.15	.33	.04	.00	.05	.96	.69	.64	.36	.09
Fix On Lt.	∞ -0	.19	.07	.07	.20	.15	.16	.04	.36	.43	.35	.40	.25	.22	.25
Divergent Rt. Eye	∞ -0	17.19	4.95	8.34	10.62	6.41	14.80	6.30	1.50	.43	1.92	.64	1.33	.20	.16
Divergent Lt. Eye	∞ -0	16.85	7.73	10.34	12.50	6.63	16.12	10.51	.97	.28	1.79	.45	.69	.31	.12

* Statistically significant

Since there were large differences in Stereopsis between First and Second grade and also slight, though non-significant, differences favoring the boys, there was a significant interaction between sex and grade. There were more girls (who were poorer in Stereopsis) in Group A across grade levels but since grade two was much more efficient than grade one, significant interaction also appeared between reading group and grade and between grade, sex and reading group.

Interaction between grade and reading group in Far Point Vertical Posture was also inevitable because of differences which strongly favored the best reading groups across grade level whereas there was also a weak effect favoring the second grade over first.

In the two-way ANOVA, there was a significant difference between reading groups on 1) Far Point Fusion and 2) Stereopsis, with the Group A mean always being superior to Group C. (See Table III) Since this measurement included both first and second grades, it would also, be largely uncontaminated by the percentage of second graders wearing glasses. It appears that good binocular vision is a major factor in reading group placement in either first or second grade.

There also were statistically significant differences in visual proficiency between age levels, six, seven and eight year olds in 1) Far Point Vision, right eye, and 2) Stereopsis. The eight-year olds having the best vision in each case. However, since 17.5% of the eight year-olds wore prescriptions compared with only 2.8% of the seven year olds, it is impossible to determine what proportion was contributed by maturation, practice in reading or prescriptions. The same trend was observable, though not statistically significant, in almost all factors which caused significant interaction between age and reading group, the means of the middle and high reading groups being best. The exception was Vertical Posture in which the seven year-olds mean was the highest. This might mean that Vertical Posture was rather closely related to reading group placement but relatively unrelated to maturation or wearing of prescriptive lens. Probably many prescriptive lens did not and/or could not correct this.

Since Group C was significantly poorer in visual efficiency than B or A, it seemed reasonable to compare the means of the 21 non-readers with those of their classmates who were learning to read easily, Group A. The outcome was much more dramatic than had been expected.

Among the nineteen non-readers in first grade, only one had adequate vision (defined as above 90% in Near and Far Point Visual Acuity and satisfactory binocular functioning). Among the 18 non-readers with vision problems there were 9 cases of no measurable fusion and 9 of no stereopsis (not the same 9 subjects). Obviously most of these children had multiple vision problems — 35 serious problems among 18 children (194%), nearly 2 each, if they had been distributed evenly.

Two of these children wore glasses, but even with their prescription, both still exhibited lack of binocular coordination (lateral posture and fusion) and not more than 90% visual acuity at near point, which is not necessarily an indictment of their prescription because when tested with and without their glasses, the prescription improved their vision on several measures. This is only to verify that all but one of the children who were non-readers (95%) had serious, uncorrected or uncorrectable visual problems whether or not they wore their prescriptive lens.

Among their age mates, the 4 sections of high achievers in the first grade (Group A from first grade only) there were 13 children who had some degree of visual deficiency, 27% as compared with 95% among the non-readers from First Grade. Among Group A, only two subjects had more than one problem compared with almost two per child among the non-readers. Obviously, a child can learn to read and even do well while having a vision problem, but it certainly puts them at high risk. This study also did not attempt to assess the amount of effort expended and frustration endured by both student and teacher in those cases.

By the close of Second grade, eleven children were wearing glasses. There were only two non-readers in Second grade and neither of those two showed any visual problems on the Keystone screening which, of course, could leave many potential problems undetected. The writer does not intend to imply that vision is the only cause of reading failure, only that it is probably the most common and therefore, a most important one. One that could be nearly eradicated if a serious attempt were made to do so.

The fact that some of the subjects wore glasses introduced an unknown amount of bias, therefore that effect was studied. In Table IV, it can be observed that the visual efficiency of the children wearing prescriptions, mostly second graders, was markedly above the overall mean of the First grade population and similar to or above the mean of the Second grade in almost all the measures of visual acuity.

TABLE III

Two-Way Analysis of Varience Showing Chronological Age and Reading Groups

Test Item (Far Point)	Range Of Perfect Score (Low to High)	Age Mean			Reading Group Mean			Main Effect		Interaction
		6 Yrs.	7 Yrs.	8 Yrs.	High	Ave	Low	Age	Reading Group	A/RG
Simultaneous Vision	3-1	1.00	1.00	1.00	1.00	1.00	1.00	.00	.00	.00
Vertical Posture	3-1	1.00	1.08	1.03	1.04	1.02	1.14	1.81	.63	*2.69
Lateral Posture	3-1	1.27	1.11	1.19	1.20	1.14	1.14	.44	.89	.82
Fusion	3-1	1.13	1.17	1.23	1.13	1.12	1.40	.23	*3.70	1.39
Useable Vision Both Eyes	49-105	102.13	99.36	101.91	98.33	102.10	101.48	.86	.50	.20
Useable Vision Rt. Eye	49-105	101.40	96.83	102.42	98.25	101.80	97.57	*3.52	.30	.89
Useable Vision Lt. Eye	49-105	101.60	96.51	100.60	97.44	101.42	95.80	1.70	.48	1.08
Stereopsis	3-1	1.43	1.13	1.16	1.14	1.18	1.70	*3.70	*4.03	2.11
Color Perception	3-1	1.06	1.16	1.03	1.05	1.11	1.14	1.87	1.26	.71
Color Perception	3-1	1.00	1.16	1.05	1.10	1.10	1.08	1.45	.04	.85

* Statistically Significant (.05)

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TABLE III
(Continued)

Test Item (Near Point)	Range Of Perfect Score (Low to High)	Age Mean			Reading Group Mean			Main Effect		Interaction
		6 Yrs.	7 Yrs.	8 Yrs.	High	Ave	Low	Age	Reading Group	A/RG
Lateral Posture	3-1	1.00	1.13	1.28	1.12	1.15	1.28	2.12	.19	.89
Fusion	3-1	1.53	1.34	1.38	1.20	1.44	1.43	.07	1.79	1.18
Useable Vision Both Eyes	10-105	93.20	93.30	93.98	96.12	93.85	89.56	.07	1.82	.36
Useable Vision Rt. Eye	10-105	93.30	93.30	96.50	97.95	94.60	89.50	2.08	2.91	.94
Useable Vision Lt. Eye	10-105	90.33	90.79	93.80	94.10	91.70	93.81	1.36	2.37	1.22

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TABLE IV

Comparison of the Visual Efficiency of First Grade Non-Readers With the Average First Grader and With the Visual Efficiency of the Children in the Most Advanced Group in First Grade

Means	N	Simultaneous Vision	Vertical Posture	Lateral Posture	Fusion	Useable Vision Both Eyes	Useable Vision Rt. Eye	Useable Vision Lt. Eye	Stereopsis	Color Perception	Color Perception	Lateral Posture	Fusion	Useable Vision Both Eyes	Useable Vision Rt. Eye	Useable Vision Lt. Eye
First Grade Non-Readers	19	1.0	1.14	1.19	1.29	97.87%	94.30%	89.40%	1.86	1.33	1.29	1.19	1.57	89.29%	90.24%	85.57%
(Total 1st Grade Mean) Average 1st Grader	67	1.0	1.18	1.17	1.15	99.04%	97.77%	96.22%	1.42	1.16	1.13	1.16	1.39	92.26%	91.70%	88.38%
(1st Grade, Group A, Mean) Average for Best Readers	33	1.0	1.04	1.21	1.12	98.19%	98.10%	97.32%	1.15	1.06	1.13	1.13	1.26	96.03%	97.81%	93.91%

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TABLE V

Comparison of Visual Efficiency of Children Wearing Prescriptive Lens in First and Second Grades With Their Own Classmates

Means	N	Simultaneous Vision	Vertical Posture	Lateral Posture	Fusion	Useable Vision Both Eyes	Useable Vision Rt. Eye	Useable Vision Lt. Eye	Stereopsis	Color Perception	Color Perception	Lateral Posture	Fusion	Useable Vision Both Eyes	Useable Vision Rt. Eye	Useable Vision Lt. Eye
Average of 1st Graders Wearing their Prescriptions	3	1.0	1.00	1.67	1.00	100.67%	95.00%	96.00%	1.67	1.00	1.00	1.00	1.67	[illegible]	97.33%	76.67%
Average of Total 1st Grade	67	1.0	1.18	1.17	1.15	99.04%	97.77%	96.22%	1.42	1.16	1.13	1.16	1.39	92.26%	91.70%	88.38%
Average of 2nd Graders Wearing their Prescriptions	11	1.0	1.00	1.36	1.55	103.00%	102.82%	101.82%	1.55	1.00	1.00	1.36	1.40	94.45%	91.73%	94.00%
Average of Total 2nd Grade	77	1.0	1.50	1.14	1.22	102.20%	101.22%	100.96%	1.16	1.05	1.08	1.22	1.36	94.53%	95.57%	95.15%

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both near and far-point. Therefore, much of the improvement between First and Second grades and between six, seven and eight year-olds can probably be attributed to eleven children having been fitted with prescriptions. However, this was not true for binocular vision (fusion, lateral posture, vertical posture, and stereopsis). Overall, there was no significant improvement in the means of any of the binocular measures between First and Second grades except for Stereopsis. The problems in binocular vision were so prevalent and severe among those wearing prescriptions that their mean even while wearing their glasses was still below the First grade mean. In several individual cases, it was verified that the prescription made a marked improvement in binocular efficiency, though binocular vision was not always or perhaps could not be made perfect on every measure.

Therefore, one must assume the significant improvement between First and Second grades in Stereopsis had multiple causation, prescriptive lens, perhaps being one factor. Practice in reading and maturation might well be others, though they did not have a measurable effect on fusion.

One of the major purposes of this study was to establish norms of normal eye efficiency in both acuity and binocular function for beginning readers and the degree of efficiency which was really needed for satisfactory progress in beginning reading.

Using the means of Group A, high achievers, and comparing them with the means of the non-readers, the assumption may be made that if a subjects Near Point Vision were below 90%, it placed a child at very high risk of failure. The mathematical mean for satisfactory progress was 94-96% since this is a figure derived mathematically and not a point on the KVS scale, it means that 50% of the children scoring 90% did well while 50% did not.

Far Point Acuity should be above 97%, while below 95% in either eye, placed the subject in jeopardy. Again, these are mathematically derived norms which indicate the near 100% are needed by most beginners and that 50% of those scoring 90 or below will not do well.

Binocular efficiency had a very narrow margin. Group A showed that a .15 (7.5%) discrepancy could be tolerated by most children in most binocular measures while a deficiency of as much as .25 (12.5%), just .10% more, definitely placed the child at a high risk. It seems that though an observable phoria may cause loss of sight in one eye and may be cosmetically objectionable, phorias that are not visable to the unaided eye, or that occur only as eyes rotate to left or right and when eyes tire (or cause the eye to tire) may cause strain and blurring and may be a very serious problem in beginning reading.

Conclusion and Discussion.

The findings from this study should be generalizable and applicable to most primary grades. The curriculum and instruction in the attendance center used for this study were above average. In schools where these factors were markedly different, other factors might enter in or the relative importance of the measurements could change.

All subjects in this study had been screened in Kindergarten by a school nurse using a Titmus Visual Screener.

The following conclusions are based on the stated findings:

1) There are significant differences in both binocular function and visual acutiy between high reading achievers and low reading achievers in visual function. This difference crossed grade, sex, age, teacher effect, and wearing of corrective lens.

2) There are significant differences between sex in a) color vision, b) Near Point Acuity, c) Stereopsis, and d) Number of fixations during return sweep.

3) Binocular problems and visual acuity problems occur with about equal frequency, although Near Point visual acuity was the single most common problem. Among the subgroup of 19 First Grade Non-readers, there were 18 cases of binocular problems together with 17 cases of inadequate visual acuity.

4) Most Non-readers had multiple vision problems, averaging 1.94%, approximately two each. 74% of these children had more than one visual deficiency while 4% of First Grade Group A had more than one.

5) The First Grade Non-readers had more than 6 times as many visual deficiencies as did the First Grade Group A.

6) Some prescriptive lens corrected both binocular and acuity deficiencies while others corrected only visual acuity.

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7) Among the subgroup who wore prescriptive lens, binocular problems were so prevalent and so severe that the mean of those who wore glasses, was still below the total First Grade mean in binocular measures, while wearing their prescription.

8) Male and female vision did not develop identically.

a) Primary girls have better Near Point vision than primary boys. This may mean that because of their faster maturation rate, girls develop Near Point vision chronologically sooner than boys.

b) Primary boys have better Stereopsis and smoother return sweep than do Primary girls. This could mean that while boys delay developing Near Point vision, they may be further refining their Far Point efficiency. (Shades of our Prehistoric ancestors! Perhaps — Men who spotted game or enemies at a distance and did not lose sight of either as it ran, provided for and protected their families better and consequently had more surviving descendents, while women who could easily discriminate between poisonous and non-poisonous berries and roots at Near Point had more offspring survive to reproduce.

9) Near Point vision problems were more than twice as common in Primary grades as Far Point problems.

10. Assuming Far Point Vertical Posture to be a casual factor in reading achievement, lack of Vertical Posture was more of a handicap in First Grade than in Second Grade, possibly because more subjects lacked it (fewer wore prescriptions) and/or because more work was done from charts, large books, and chalkboard at Far Point in First Grade than in Second.

11) The left and right eyes do not develop identically. Since this is also true of the right and left brain, use and size of the right and left hands, and size and use of left and right feet, it should not be so surprising. It had not been anticipated, however.

12) It was even suggested by the data that each eye may serve or be dominate in different functions while reading. This was implied by the right eye usually showing better acuity while the left eye was better, (had fewer) refixations, at the beginning of the following line.

13) Visual acuity with both eyes was not necessarily as good as with the better of the two eyes, individually. Possible explanations are that a) the better eye is not always dominate, as has often been suggested in the literature or, and equally plausible, b) there may be differences or deficiencies in fusion which may blur the vision of the better eye when both are used.

14) Vision screening done during First and Second Grades was too late. Ninety-five percent of the First Grade Non-readers had serious vision problems suggesting that if a *rigorous* visual screening *and follow-up* were carried out at a Kindergarten round-up and during the following Kindergarten year, up to 95% of reading agony, humiliation and problem behavior on the part of the small child (and his parents) not to mention much of the teacher burn-out might be prevented.

15) Color vision was a real factor to be seriously considered in reading achievement and should justify discontinuance of the use of any copied material that was not black on white with clearly and sharply defined lettering. A flagrant example of that which should be avoided are the pale purple dittos, which are so very common in most classrooms. Charts and chalkboards should always be black and white. Though the percentage of children so afflicted is not great, it cannot be corrected by glasses or therapy, and from the number identified one should assume that there would always be one or more of these children in every classroom.

16) Percentages, although generally useful, were relatively meaningless when considering an individual child. If there was even *one* problem which prevented his/her from seeing print, it *could* be sufficient to cause him/her to be a Non-reader. If there were any combination of minor problems which would make visual discrimination tiring, it would probably keep the child out of the high achieving group.

If they were immature, hyperactive, unmotivated, or ill, it would require *very* little in the way of visual impediments to cause rejection of the reading task.

Specific methods or materials such as purple dittos, colored ink on colored pages in books and charts or yellow chalk on pale green chalkboard, or a method such as Words in Color could be sufficient to totally block reading progress for a child who had a seemingly rather innocuous visual problem such as color blindness. In these cases the printing could vary from very faint to totally invisible.

Further research should be done as soon as possible on the readability and effects of computer print on vision including color effect and the effect of lighted screens on normal and light sensitive eyes.

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Perhaps problems in this new instructional media could be prevented rather than corrected some time in the future.

Another more theoretical question that deserves further investigation is why the right eye had fewer fixations that the left. Another similar question, was why the fixations of the right eye increased from the First Grade to the Second Grade.

One of the original questions which had been posed by this research but which at the close of the investigation seemed relatively unimportant, was how many children have perfect vision defined as no detectable deficiency. This research revealed that 89.6 percent did not have perfect vision and only utilized two evaluating instruments, indicating a more thorough investigation would yield even a greater percentage. Obviously, *perfect* vision, like perfect teeth, is very rare, and perhaps non-existant and perfection is not particularly necessary for reading.

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INSIGHTS IN SIGHT

Vision, Not Visual Perception, Major Factor in Reading Disability

Abstract

Because of great differences in opinion between recognized authorities from various fields, the purpose of this study was to determine emperically whether there were significant differences in vision between beginning readers who achieve reading skills easily and those who learn with great difficulty, often termed dyslexics. Secondly, if a difference existed, to determine by the mean of the high achievers, rather than expert opinion, what degree of visual efficiency was normally needed for successful acquisition of reading in First and Second grades as measured by the Keystone Telebinocular Screener and the EDL Moving Eye Camera, Eye-Trac Model 106.

The subjects consisted of the total First and Second grade population (N 144) in a public elementary school in Texas, USA. Mean CA was 7 yrs. 3 mo. Subjects were 60% Caucasion, 30% Negro, 5% each, Oriental and Mexican. Male-female ratio was 55-45. Socio-economic levels ranged from low to upper-middle class. Eight self-contained classrooms had each been divided by achievement into three reading groups, high, average, and low, making a total of 24 subgroups under eight different teachers. Each child was tested individually at the close of the school year on 25 visual factors in a private conference room at his/her attendance center. The examiner had no knowledge of the students reading group placement. Factorial designs were used and the resulting data subjected to ANOVAs.

Statistically significant differences in visual function were found between high and low achievers across grade, sex, age, and teacher effect. The means of the high achievers were superior to the poor achievers on almost all measures. Significant differences appeared in 1) Binocular Function; Far-Point Vertical Alignment, Stereopsis, Fusion, and Ability to make a smooth return sweep to the beginning of the following line, and 2) Near-Point Visual Acuity. A subgroup within the low achieving group, 19 Non-readers in First grade, had a mean discrepancy of 7.76% between their eyes in Usable Vision at Far-Point, while the First grade high achievers had only 0.5%. Among the 19 Non-readers, there were 18 cases of binocular problems and 17 cases of inadequate visual acuity, six times the number of visual problems, NOT VISUAL PERCEPTION, that were found among the First grade high achievers. Ninty-five percent of the Non-readers had serious visual problems.

It appears that up to 95% of the Reading Disabled have been mislabeled. Most of their difficulties could have been prevented by a much more rigorous Kindergarten or Pre-school visual screening and follow-up program.